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## Ecological Restoration

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supporting agriculture in urban open spaces would contribute to community sustainability (Bryld, 2003) and resilience, while providing opportunities for urban environmental education.

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## ECOLOGICAL RESTORATION

Elizabeth P. McCann and Tania M. Schusler

### Highlights

- Ecological restoration involves revitalizing neglected, degraded, damaged, or destroyed habitats.
- Restoration-based education involves learners in ecological restoration with an intentional educational purpose.
- Urban restoration-based education can enhance personal and community well-being while improving ecosystem services in degraded environments.
- Restoration-based education can benefit from consciously forming partnerships, integrating local values alongside socioeconomic and ecological considerations, and being sensitive to issues of power and diverse cultures.

### Introduction

Urbanization has destroyed and fragmented native habitat, leading to biodiversity loss. Yet many urban areas remain home to pockets of ecological diversity. And postindustrial, degraded urban sites have tremendous potential for both biological and cultural revitalization. Recognizing this potential, people in cities around the globe are engaging in ecological restoration, which in addition to revitalizing degraded sites, can develop leadership, teamwork, job readiness skills, and interest in conservation careers among participants (Figures 26.1–26.3).



**FIGURE 26.1.** Members of the Friends of the Forest Preserve's Conservation Corps remove invasive species to restore native prairie and savanna surrounding Powderhorn Lake in Chicago. Credit: Alex Russ.



**FIGURE 26.2.** Students at Rocking the Boat help restore oyster reefs in New York.



**FIGURE 26.3.** Volunteers at the Bang Pu Nature Education Centre learn about the local environment and restore mangrove forest in Bangkok's suburbs. Credit: Alex Russ.

In ecological restoration, humans renew or restore degraded, damaged, or destroyed habitats and ecosystems. This can involve activities like cutting invasive brush to restore ecosystem structure of an oak savanna, planting native seedlings to encourage the regeneration of a forest, or enabling periodic flooding to restore hydrological processes in a wetland. While biologists and ecologists focus on restoration as a strategy to conserve biodiversity, ecological restoration also can enable meaningful human interaction with the natural world in urban areas where most of the world's population resides. By promoting both human-nature and human-human interactions, restoration initiatives are well-suited to enhance the resilience of individuals, communities, and ecosystems.

Krasny et al. (2013) describe that learning through ecological stewardship and restoration projects in Asia, Africa, and North America occurs along a continuum from informal educational opportunities to those intentionally planned and designed. Wherever along this continuum learners engage collectively in activities to restore ecosystems, both learning and transformation of degraded social-ecological systems are possible. This chapter focuses on those ecological restoration efforts intentionally designed to include an educational purpose,

itself, restoration-based education is a process occurring over time that includes social and ecological components. Restoration-based education has the potential to create learning landscapes that enhance biodiversity and ecosystem services while offering learners—including children, adults, and families—opportunities to reverse negative environmental trends through their collective hands-on/minds-on efforts.

Restoration often focuses on revitalizing natural habitats, but Standish, Hobbs, and Miller (2013) suggest that restorationists also consider novel ecosystems and gardening with iconic species, given the altered biophysical realities and constraints within cities. All these options hold the potential to bolster learners' knowledge, attitudes, and motivation to act as stewards in their community. Participating in restoration also offers learners opportunities to explore and connect with the natural world in urban contexts. Exposure to natural elements like water, trees, flowers, grasses, animals, and other diverse life forms fosters human creativity and imagination. This chapter describes some of the contexts where restoration-based education occurs, highlights educational and ecological impacts, and discusses the importance of partnerships, inclusivity, cultural relevance, and social justice in the restoration education process.

### Restoration-Based Education: Contexts and Impacts

Restoration-based education occurs in formal and nonformal educational settings. For example, it may take place in a schoolyard, through service learning at a university, within a summer youth program, as part of a green jobs training program, or as residents in a neighborhood or region join volunteer stewardship networks. Learners engage in direct, hands-on activities such as removing invasive species or collecting and planting native seeds, and in research, planning, monitoring, and evaluating outcomes of their restoration efforts. Restoration goals can focus on education and other human outcomes, such as science learning, youth development, or job skills, or education can be embedded within projects whose primary goal is restoring native species and ecological processes. Regardless of the main goal, restoration-based education can simultaneously benefit individuals, communities, and ecosystems as it engages people in collective actions to improve their local place.

Restoration projects in schoolyards invite students to explore the wonders of nature just outside their classrooms. Teachers can use a small plot of ground to teach natural history, science, math, art, geography, and other subjects. Research indicates that through active involvement in schoolyard restoration projects,

students become “attuned to the living world in ways that the lawn-and-asphalt landscaping more typical of schoolyards simply will not allow” (Bell, 2001, pp. 152–153). For example, a year-long project involving invasive species removal in degraded urban ecosystems—on school grounds and in public green spaces—increased middle school students' environmental awareness and motivation to serve as stewards (Dresner and Fischer, 2013).

Earth Partnership provides a model for restoration-based education, which emphasizes a ten-step cyclical process that encompasses planning and hands-on restoration efforts in school and community contexts. Examples of planning activities include studying local species and habitats, investigating site history and landscape patterns, and analyzing site design considerations like soils, shade, and aesthetics. Hands-on activities include site preparation, planting, and invasive species removal (Hall and Armstrong, 2011; McCann, 2011). Another important component is community outreach, which has facilitated learning and environmental outcomes in urban contexts like Chicago, Detroit, Cleveland, Sacramento, southeast Florida, and Puerto Rico. Earth Partnership recently launched three initiatives—Latino Earth Partnership, Indigenous Arts and Sciences, and Global Earth Partnership—to expand their educational efforts based on this cyclical restoration education model (Cheryl Bauer-Armstrong, personal communication, 2016). The multiple phases of restoration processes provide diverse opportunities for learning through action. Such action can vary from one-time events to long-term investment in a particular urban restoration project; longer-term learner engagement, however, is likely to have greater educational impact.

Involvement in designing or planning restoration projects can lead to learning for both students and adults. In Seattle, sixth graders who actively engaged in charrettes for the design of a park-based, outdoor learning laboratory increased their understanding, caring, and competence regarding habitat creation and restoration (Rottle and Johnson, 2007). In the Cape Flats Nature initiative in Cape Town, South Africa, local organizations and schools helped identify ways that natural areas and associated restoration efforts provide ecosystem services in oppressed, impoverished contexts (Ernstson et al., 2010). In Ames, Iowa, public participation in designing and implementing a restored urban riparian buffer resulted in collaborative learning about water quality, familiarity with storm water management, and changed perceptions of stream ecosystem functions. These outcomes relied on opportunities for dialogue, ongoing interaction among researchers and participants, flexibility, and hands-on engagement of urban residents (Herringshaw, Thompson, and Stewart, 2010).

In addition to environmental learning, restoration can be a means toward other youth outcomes, such as green jobs training or positive youth development.

For instance, MillionTreesNYC demonstrated potential for engaging low-income eighteen- to twenty-four-year olds in restoration through green-collar employment training. While challenges exist, this case showed promise for catalyzing intellectual engagement, social and emotional benefits, and a sense of accomplishment among participating youths (Falxa-Raymond, Svendsen, and Campbell, 2013). Kudryavtsev, Krasny, and Stedman (2012) documented how action-oriented, direct experiences like restoration projects in youth programs facilitate ecological place meaning and enhance teens' lives in the Bronx in New York City.

Studies indicate that restoration-based education can benefit ecosystem services, biodiversity, and ecosystem health alongside student and teacher learning outcomes (McCann, 2011; Hall and Bauer-Armstrong, 2011). For instance, a 2005 study of four Wisconsin school restorations determined that while the restored school grounds lacked ecological integrity, they had more animal and plant life—and teacher and student engagement—than the previously monotonous landscapes (Anthonisen, 2005). Similarly, New York City schools and their partner organizations' oyster restoration efforts (Figure 26.2) seek to filter pollutants from harbor water.

Inclusive urban ecological restoration reflecting diverse values and perceptions of nature can strengthen connections to local nature, enhance neighbors' sense of community, and lead to other community development projects. For example, in Toronto, local perspectives realigned a restoration beyond its initial rewilding purposes toward other local interests like food production, health, and employment (Newman, 2011). Palamar (2010) argues that environmental justice principles can be employed to improve the design and implementation of restorations, particularly in urban contexts where social and ecological considerations are key. Her case study of New York City's Green Guerillas illustrates the potential for communities to recognize their own needs and cultivate the expertise required for some types of ecological restoration projects.

Restoration-based education can be considered a civic ecology practice, which is a community-based environmental stewardship action that enhances green infrastructure and well-being, particularly in urban contexts (Krasny and Tidball, 2015). Community-based restoration projects fall within this framework, including watershed restoration and similar initiatives such as community forestry and community gardens. Attributes of cultural diversity, ecosystem services, diverse knowledge and experience, adaptive learning, social learning, self-organization, and social capital all contribute to resilient social-ecological systems. In urban contexts, Krasny and Tidball (2015) contend that civic ecology practices may cultivate resilience by enhancing biological diversity and ecosystem services, integrating various forms of knowledge and emphasizing participatory approaches to natural resource management

## Restoration for All: Partnerships, Inclusion, and Justice

The remainder of this chapter focuses on key considerations for successful restoration education efforts. First, effective restoration-based education involves partnerships among multiple organizations, such as schools, universities, natural resource agencies, local governments, nonprofit organizations, grassroots citizens groups, museums, and science centers. Krasny et al. (2013) emphasize the essential role of partnerships in restoration projects ranging from dragonfly habitat in Japan and indigenous species restoration in Cape Flats, South Africa, to the large-scale Cheonggye-cheon River restoration in Seoul, South Korea, each of which resulted in varying educational, ecological, communal, and cultural benefits. The multidecade Bronx River restoration project in New York City is a partnership of schools, community groups, nonprofit organizations, government agencies, and businesses located within the Bronx River watershed (Krasny and Tidball, 2015).

Like other ecosystems, urban ecosystems are cultural constructs, reflecting the values, beliefs, and behaviors that shape them. In the process of forming partnerships, educators and ecologists run the risk of prioritizing scientific knowledge and goals over local knowledge and community-based values. Even the term "restoration" can be interpreted metaphorically and holds underlying assumptions of rationality and human capacity to improve upon a natural resource. Describing extensive restoration efforts in Chicago, Illinois, and San Francisco, California, Gobster (2012) outlines social, ecological, and managerial considerations when undertaking restorations in urban contexts to meet diverse goals. His case study of park lands along Chicago's lakefront reminds us that nature means different things to different people, which must be accounted for in restoration processes. Gobster's (2012) long-term research about these large metropolitan regions informs his suggestion that urban park restorations consider a wider array of values and uses for youths and adults. Attention paid to inclusivity and authentic participation, particularly in dense urban contexts, can avoid favoring one type of nature over another and inadvertently privileging some groups while excluding others.

Along with balancing social and ecological considerations, urban restoration-based education should be culturally responsive. Culturally competent educators acknowledge the interconnectedness of place and culture, demonstrate an acute sensitivity to learners' personal experiences in their total environment, and realize that such experiences often entail oppression across race, class, gender, and other cultural dimensions (Newman 2011; Gruenewald, 2008, cited in McCann, 2011: see also chapter 6). To be inclusive, scientists, planners, educators, and

community members make space in the process of designing and implementing a restoration project for cultural perspectives that reflect ways of knowing beyond the dominant Western, positivistic tradition of individualism, linear progression, and rationality. Doing so embraces a wider array of voices, ideas, and possibilities. Authentic, culturally inclusive engagement of youths and adults, attention to human development and learning, interdisciplinary curricular integration, and evaluation are key considerations for effective restoration-based education (McCann, 2011).

Respecting local cultural values and knowledge helps to counter the risk that restoration, and education embedded within it, alienates disadvantaged people and neglects social justice. Inherent tensions exist within the desire to enhance ecosystem services provided through urban green space restorations. As cities realize the potential for remnant urban lands and other underutilized spaces to boost ecosystem services and improve city dwellers' health and well-being, urban greening may also increase housing and property costs, resulting in gentrification, displacement of low-income residents, and continued disparities in access to green space. Communities of color and low-income neighborhoods rife with public health challenges oftentimes have limited access to safe, well-managed parks and other open space. Tomblin (2009) outlines intersections between the ecological restoration movement and the environmental justice movement and points out commonalities across them. Indigenous Peoples' Restoration and Environmental Justice Restoration illustrate how justice and restoration efforts can intersect to consider the ecological, cultural, and justice elements of restoring degraded ecosystems.

In short, consciously forming partnerships; integrating local values, traditions, and socioeconomic alongside ecological considerations; and being sensitive to diverse cultures and issues of power are critical to restoration-based education. Doing otherwise can lead to misinterpretations, failure, and even environmental injustices. By applying these principles, restoration-based education can become an important tool in urban environmental education.

## Conclusion

Restoration-based education, that is, ecological restoration efforts intentionally designed to include an educational purpose, offers a way to restore urban habitats and ecosystem services while increasing learners' ecological understanding and enhancing individual, community, and ecosystem resilience. Involvement through various phases of a restoration project—whether in a vacant lot, schoolyard, or larger ecosystem—can allow youths and adults to feel a sense of

ownership, competence, and connection to their place and community. Learners across the lifespan begin to understand ecological concepts and investigate the natural and cultural history of a place that is (or may become through restoration action) important and relevant to them. This engagement, in turn, can result in participants viewing themselves as part of a larger system, rather than removed from the natural world or thinking that they live in a world without solutions.

When done well, urban restoration-based education can bridge the gap between the natural and built environment through hands-on community engagement. In this era of globalization and transformation of cities and their landscapes, inspirational restoration initiatives have been launched across the globe. Environmental educators have the opportunity to further facilitate change through inclusive, just restoration education practices, which in turn positively impact urban sustainability.

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## GREEN INFRASTRUCTURE

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### Highlights

- Green infrastructure, such as urban parks, community gardens, green buildings, and green roofs, represents a network of human-managed and natural ecosystems that together enhance ecosystem health and climate change resilience, contribute to biodiversity, and benefit human populations through the maintenance and enhancement of ecosystem services.
- Environmental education *in, about, and for* green infrastructure provides significant opportunities for improving human-nature connections in the city.
- Environmental education *in* green infrastructure entails formal and informal place-based learning in built and natural green infrastructure settings.
- Environmental education *about* green infrastructure offers a framework for teaching about the benefits of urban green infrastructure, such as ecosystem services.
- Environmental education *for* green infrastructure provides opportunities for promoting urban environmental stewardship by engaging residents in the planning, maintenance, and use of green infrastructure projects.

### Introduction

The term “sustainable city” evokes images of green roofs, energy-efficient buildings, bioswales, bike lanes, urban forests, and other types of green infrastructure. These urban features clearly have value for ecosystem and human health. but